TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

1. INTRODUCTION

The Town of Lexington, Massachusetts ("the Town") is situated within three major watersheds: the Charles River watershed, the Mystic River watershed, and the Shawsheen River watershed. The Town has undertaken a three-part effort to develop a stream management plan for each watershed in Town. The Charles River watershed plan was completed in April 2011. This report builds off the plan developed for the Charles River watershed and substantial work completed by the Town and the Watershed Stewards throughout the Shawsheen River basin to present a management plan for the Shawsheen River streams within the Town of Lexington.

Because of the previous work completed, Woodard & Curran (W&C) worked closely with the Town and the Stewards throughout development of this plan. The Town and the Stewards identified survey areas and stream crossings throughout the watershed based on known problems, stream walks, public complaints, and areas of frequent maintenance. The Survey Areas and culverts identified are listed on Table 1 and shown on Figure 1.

Together with Town staff, Woodard & Curran conducted an assessment of the Survey Areas and stream crossings to address the specific known problems and also to identify additional problems, ultimately to define solutions for these areas and create a long term maintenance program that will enable the Town to maintain drainage and stream flow, reduce sedimentation, address specific water quality issues, and enhance streambank stability.

Gaining an understanding of the existing characteristics of these waterways and associated wetlands, as well as their stormwater infrastructure, is essential in effectively managing these resources and protecting property from flooding, while restoring stream hydrology and health. This study explores and develops a cohesive strategy for drainage rehabilitation and restoration.

1.1 DRIVERS FOR STUDY

There are numerous drivers for this study, including known water quality problems and existing and pending stormwater regulations. The Vine Brook and Kiln Brook have bacteria impairments and are subject to a final Total Maximum Daily Load (TMDL) (see Section 2.1.2 for further details). The Town is currently subject to the 2003 General Permit for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems (MS4). In early 2010, the U.S. Environmental Protection Agency (EPA) released a draft National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges from Small MS4s located in North Coastal Massachusetts ("EPA Phase II Small MS4 General Permit"). This draft General Permit identifies Best Management Practices Lexington must implement to control stormwater pollution. The Town is required to address the final TMDL for waterbodies in the Shawsheen River basin.

In addition, the Town has conducted extensive monitoring and assessment work throughout the Shawsheen River watershed, particularly in Vine Brook, and has numerous reports summarizing findings in various locations in the watershed and recommending specific solutions:

- Report on Stormwater and Drainage Improvements at the Pine Meadows Golf Club for the Town of Lexington, MA prepared by Tutela Engineering Associates, Inc. (April 2008);
- Vine Brook and Willard's Brook Stream Shoreline Surveys prepared by the Watershed Stewards (May 9, 2009);

- Lexington Center Streetscape Concept Plan & North Side Design prepared by Pressley Associates (July 1, 2011);
- Town of Lexington, MA Minuteman Commuter Bikeway Drainage Improvement Project, prepared by GCG Associates Inc. (September 2011);
- Pine Meadows Golf Club Stormwater Collection Restoration and Improvements (September 2010);
- Lexington Brook Management Manual, Lelito Environmental Consultants (October 1993);
- Water Quality Survey of Old Reservoir Recreational Beach, Louis Berger Group, Inc. (March 2008); and
- Lincoln Fields Memorandums.

1.2 PROJECT OBJECTIVES

The primary goal of this study was to create a program that can both restore drainage and enhance streams. The three specific objectives of this study were to identify:

- A means of improving drainage throughout the watershed, which includes restoring urban drainage and stream flow/functions;
- Infrastructure problems/failures with the related issue of protection of private property (erosion, flooding); and
- Opportunities for water quality improvements such as reducing pollutant sources and implementing proactive drain/stream maintenance, including relieving sediment issues.

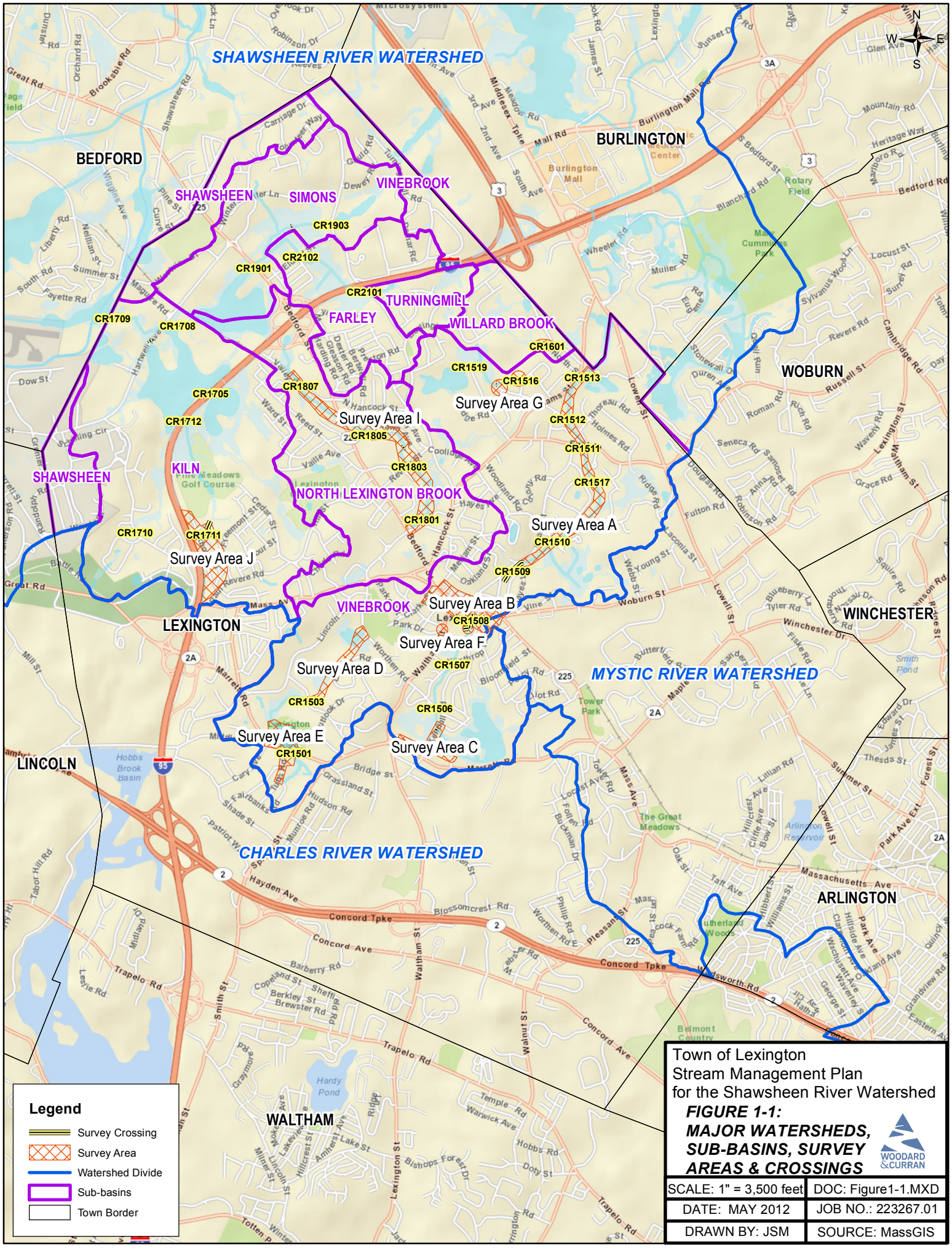
Additionally, information gathered from this study can be used to support implementation of State and Federal stormwater management requirements as well as to support management of other watersheds within the community.

Woodard & Curran worked collaboratively with representatives from the Town Engineering Division, Conservation Office, Highway Division, and the Watershed Stewards and also solicited input from town residents and neighboring communities. A final public meeting was held on October 11, 2012, to present recommendations and priorities. This collaborative approach helped to:

- Tap the experience and knowledge of the Watershed Stewards and other advocates in Lexington;
- Develop an on-going and interactive dialogue with the citizens of Lexington;
- Identify drainage needs, infrastructure restoration, and opportunities for stream management;
- Prioritize projects, including costs and benefits; and
- Target funding alternatives.

Table 1-1: Shawsheen River Watershed Survey Areas

Survey Area	Sub-Basin	Description
Survey Area A	Vine Brook	Lower Vine Brook (Hayes Lane through Saddle Club area to Butterfield Pond – stream maintenance and restoration alternatives)
Survey Area B	Vine Brook	Culverted portion of Vine Brook (Downtown BMP retrofit inventory in area bordered by the rail trail and Vinebrooke Village from Fletcher Ave to Merriam Street, comprised of a review of GIS mapping and a one-day field review)
Survey Area C	Vine Brook	Headwaters of the South Branch (Grapevine and Ryder Lane, Apollo Circle neighborhood urban drainage (flooding issues) and Kendall Road stream crossing)
Survey Area D	Vine Brook	Culverted Portion of the North Branch (Lincoln Park day-lighting option and walking survey to Middleby Road)
Survey Area E	Vine Brook	North Branch headwaters and wetlands (Drainage issues south of Old Res between Tufts Road and Spring Street and interconnectivity to Old Res level control and bypass outlet pipe)
Survey Area F	Vine Brook	North Branch culvert inlet at Waltham Street and South Branch culvert inlet at Vinebrooke Village
Survey Area G	Vine Brook	Vine Brook Tributary (Brent Road culvert review and Suzanne Road inlet inspection)
Survey Area H	Willard'ss Brook	Pond to road crossing day-lighting option at Willard's Woods
Survey Area I	N. Lexington Brook	Minuteman Rail Trail from Camilla Place to Valley Road, stream restoration alternatives, maintenance, and culvert inspections, including large parking area
Survey Area J	Kiln Brook	Tributary Channels and headwaters of Kiln Brook (Constitution Road and MassDOT sediment issues along Ross Road and Oxbow Road, specifically along MassDOT right-of-way, at Ross Road outlet and blockages of Oxbow Road 36" inlet)
Survey Area K	Simons, Farley and Turning Mill Brooks	Various crossings and outfall locations along Brooks


SHAWSHEEN RIVER WATERSHED
BEDFORD
BURLINGTON
WOBURN
WINCHESTER
ARLINGTON
LEXINGTON
LINCOLN
WALTHAM
SHAWSHEEN
SIMONS
VINEBROOK
FARLEY
TURNINGMILL
WILLARD BROOK
KILN
NORTH LEXINGTON BROOK
CR1709
CR1708
CR1901
CR1903
CR2102
CR2101
CR1807
CR1705
CR1712
CR1805
CR1803
CR1801
CR1711
CR1710
CR1519
CR1516
CR1513
CR1601
CR1512
CR1511
CR1517
CR1510
CR1509
CR1508
CR1507
CR1506
CR1503
CR1501
Survey Area I
Survey Area G
Survey Area A
Survey Area B
Survey Area F
Survey Area D
Survey Area C
Survey Area E
Survey Area J
MYSTIC RIVER WATERSHED
CHARLES RIVER WATERSHED
Legend
Survey Crossing
Survey Area
Watershed Divide
Sub-basins
Town Border
Town of Lexington
Stream Management Plan
for the Shawsheen River Watershed
FIGURE 1-1:
MAJOR WATERSHEDS, SUB-BASINS, SURVEY AREAS & CROSSINGS
WOODARD &CURRAN
SCALE: 1" = 3,500 feet
DOC: Figure1-1.MXD
DATE: MAY 2012
JOB NO.: 223267.01
DRAWN BY: JSM
SOURCE: MassGIS

2. STREAM ASSESSMENT

This section presents an assessment of streams in the Shawsheen River watershed within the Town of Lexington. The assessment includes a description of each sub-basin, a detailed field investigation of the survey areas and culverts in the Shawsheen watershed, and a catalogue of current activities and operations that affect stormwater, drainage, and stream management in the watershed.

2.1 WATERSHED DESCRIPTION

As previously discussed, the Town is situated within three major watersheds: the Charles River watershed, the Mystic River watershed, and the Shawsheen River watershed. The Shawsheen River watershed covers the largest portion of town, and includes Lexington's downtown area. Figures 1-1 and 2-1 show the major watershed divides in Lexington, according to MassGIS Major Drainage Basins (last updated in March 2003) and the Town's delineation of the Shawsheen River watershed.

2.1.1 Sub-Basins

The Town had previously divided the Shawsheen River watershed within the Town into seven sub-basins, as shown on Figures 1-1 and 2-1:

- Farley Brook;
- Kiln Brook;
- North Lexington Brook;
- Simons Brook;
- Turning Mill Brook;
- Vine Brook; and
- Willard's Brook.

These sub-basins were delineated by the Town of Lexington, and modified by Woodard & Curran at the town border with the Town of Lincoln. It should be noted that Turning Mill Brook flows into Farley Brook, and then into Simons Brook. Willard's Brook is a tributary of Vine Brook, and North Lexington Brook and Simons Brook are tributary to Kiln Brook.

2.1.1.1 Impervious Cover

Impervious cover includes buildings, roads, sidewalks, driveways, parking lots, and other surfaces that do not allow rainwater to infiltrate into the ground and can contribute to increases in peak stormwater runoff, stream geomorphology and impairments to receiving waterbody chemistry. Impervious cover also routes pollutants quickly to waterbodies and restricts groundwater recharge. Impervious cover often used as an indicator of overall stream health. Basins with impervious cover exceeding 10% of the watershed land

area generally have impaired water quality, according to the EPA[1] and studies from the Center for Watershed Protection.[2]

Reduction or management of impervious cover should result in a decrease in stormwater quantity, thereby resulting in reductions in flooding, reduced sediment transport to stream channels, and restoration to water quality and stream health. EPA's draft North Coastal Phase II Small MS4 General Permit includes numerous requirements relating to tracking and reducing impervious cover.

Impervious cover was assessed for each of the Shawsheen River sub-basins based on impervious cover data from MassGIS. As shown in Table 2-1, all sub-basins in the Shawsheen River Watershed have greater than 10% impervious cover, and approximately 21% of the entire Shawsheen watershed within Lexington is covered by impervious surfaces. Figure 2-1 shows impervious cover in each watershed.

Table 2-1: Shawsheen River Watershed Sub-basins

Sub-basin	Total Area (acres)	Impervious Area (acres)	Impervious Cover (%)	Roadway in Sub-basin (Miles)
Simons Brook	460	104	23	5.8
Farley Brook	329	73	22	9.2
Kiln Brook	1,159	223	19	21
Willard's Brook	150	17	11	2.1
Turning Mill Brook	92	13	15	1.4
North Lexington Brook	770	201	26	21
Vine Brook	1,887	403	21	38

Source: MassGIS, Town of Lexington, Woodard & Curran

2.1.1.2 Land Uses with High Potential Pollutant Loads

There are particular land uses that have a high potential for pollution of stormwater. In the Shawsheen River watershed, the primary pollutant of concern is bacteria, which can come from numerous sources, including wildlife on natural areas such as forest, wetlands, pasture, and pet waste from improper disposal in residential areas or high use recreation areas. Other land uses such as commercial/industrial can contribute pollutants such as sediment or metals. As part of the stream assessment, Woodard & Curran reviewed land uses in the watershed for areas that have a high potential to contribute pollution to stormwater. Figure 2-1 shows land uses throughout the watershed based on MassGIS 2005 Land Uses. Areas identified for high potential stormwater pollution are addressed as part of the recommendations summarized in Section 4 and further detailed in the Fact Sheets in Section 7.

2.1.2 Water Quality in the Shawsheen River Watershed in Lexington

As designated in Massachusetts Surface Water Quality Standards (314 CMR 4.00), the streams within the Shawsheen River watershed in Lexington are considered Class B waterbodies. Figure 2-2 shows the

1 "Although IC is not the direct factor causing the impairment, it is a good indirect or surrogate measure because of the relationship between impervious surfaces and stormwater-related water quality problems." http://www.epa.gov/owow_keep/tmdl/tmdlsatwork/eagleville_brook.html

2 Impacts of Impervious Cover on Aquatic Systems (Center for Watershed Protection, 2003).

location of waterbodies and the associated water quality standard. Class B waterbodies are to be used as a habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation.

Waterbodies are impaired when they do not meet surface water quality standards and when they do not have the capacity to support their uses (aquatic life support, fish and shellfish consumption, drinking water supply, and primary (e.g., swimming) and secondary (e.g., boating) contact-recreation), as identified in the surface water quality standards. The Massachusetts Integrated List of Waters identifies impaired waterbodies and the reason for impairment (pollutants of concern).

Waters that are impaired or threatened for one or more uses and require development of a TMDL are known as Category 5 waterbodies on the 303(d) list. Once a waterbody is listed in Category 5 on the 303(d) list, development of a TMDL is required for each pollutant of concern associated with that waterbody. Once a TMDL is developed for a pollutant in a waterbody, that waterbody is removed from the 303(d) list for that pollutant and categorized as a Category 4 waterbody.

As shown in Figure 2-2, per the proposed 2012 Massachusetts Integrated List of Waters, one waterbody in the Shawsheen River watershed in Lexington is identified on the 303(d) list:

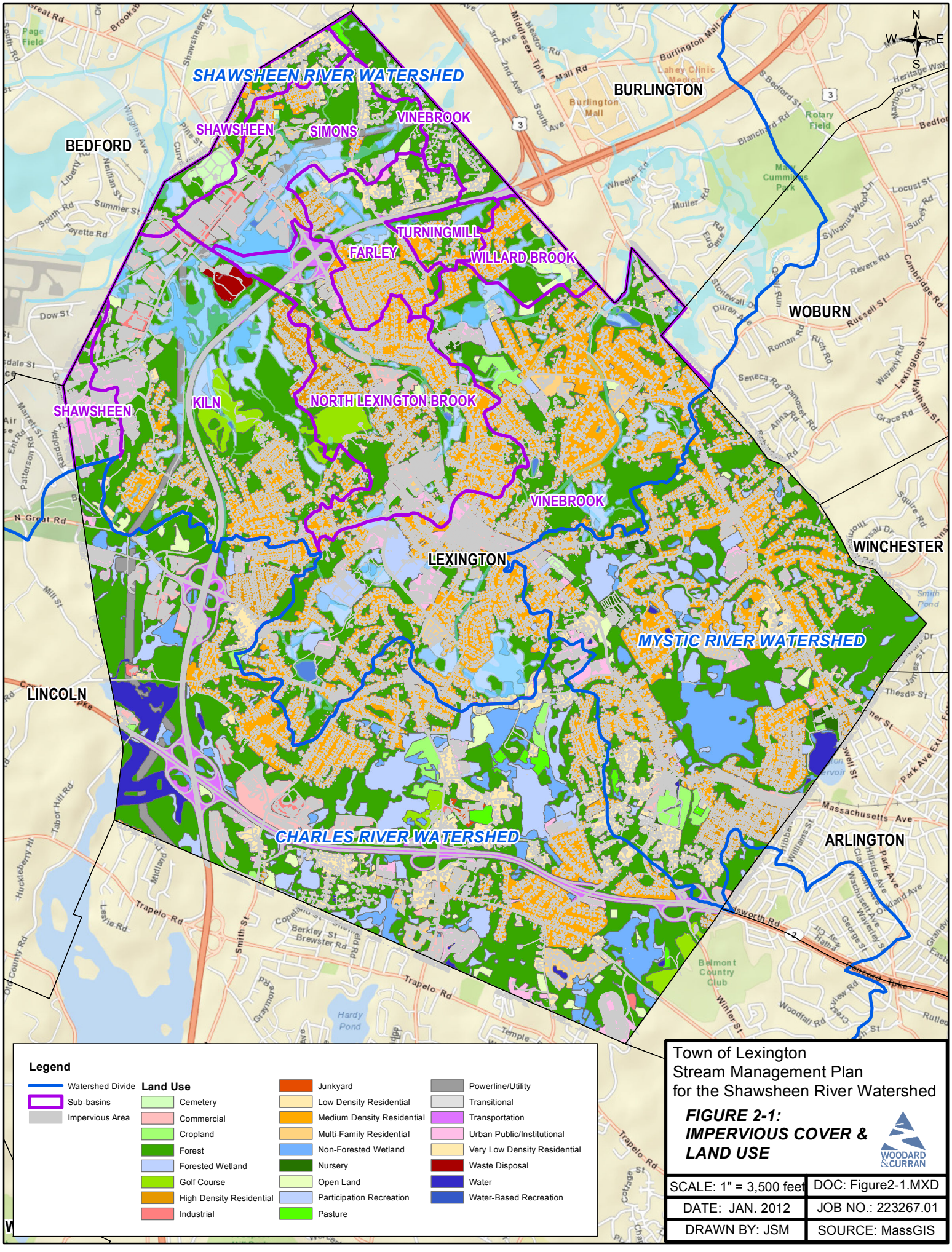
- Butterfield Pond (Segment ID MA83003) (Burlington/Lexington line) requires development of a TMDL to address noxious aquatic plants and turbidity.

A TMDL is the greatest amount of pollutant that a waterbody can accept and still meet water quality standards for protecting public health and maintaining the designated beneficial uses of those waters for drinking, swimming, recreation, and fishing. TMDL reports identify the potential sources of contamination, establish pollutant loading limits, and outline corrective actions to achieve these limits. EPA and the MassDEP recognize that restoring polluted waters is a long-term process. Two TMDLs are relevant to the Shawsheen River portion of the Town of Lexington:

- Total Maximum Daily Loads of Bacteria for Shawsheen River Basin (TMDL Report MA83-01-2002-24 CN 122.0, August, 2002).
- Draft Storm Water Pollutant Total Maximum Daily Load for Headwaters of the Shawsheen River (TMDL Report MA83-08-2003-01, June 2003).

This Final TMDL for Bacteria applies to two Category 4 waterbody segments, as shown on Figure 2-2:

- Kiln Brook (Segment ID MA83-10), from the outlet unnamed pond (in Pine Meadows Country Club), Lexington, to confluence with Shawsheen River, Bedford (1.5 miles).
- Vine Brook (Segment ID MA83-06), from the headwaters (southeast of Granny Hill) near Grant Street, Lexington to confluence with Shawsheen River, Bedford (6.8 miles).

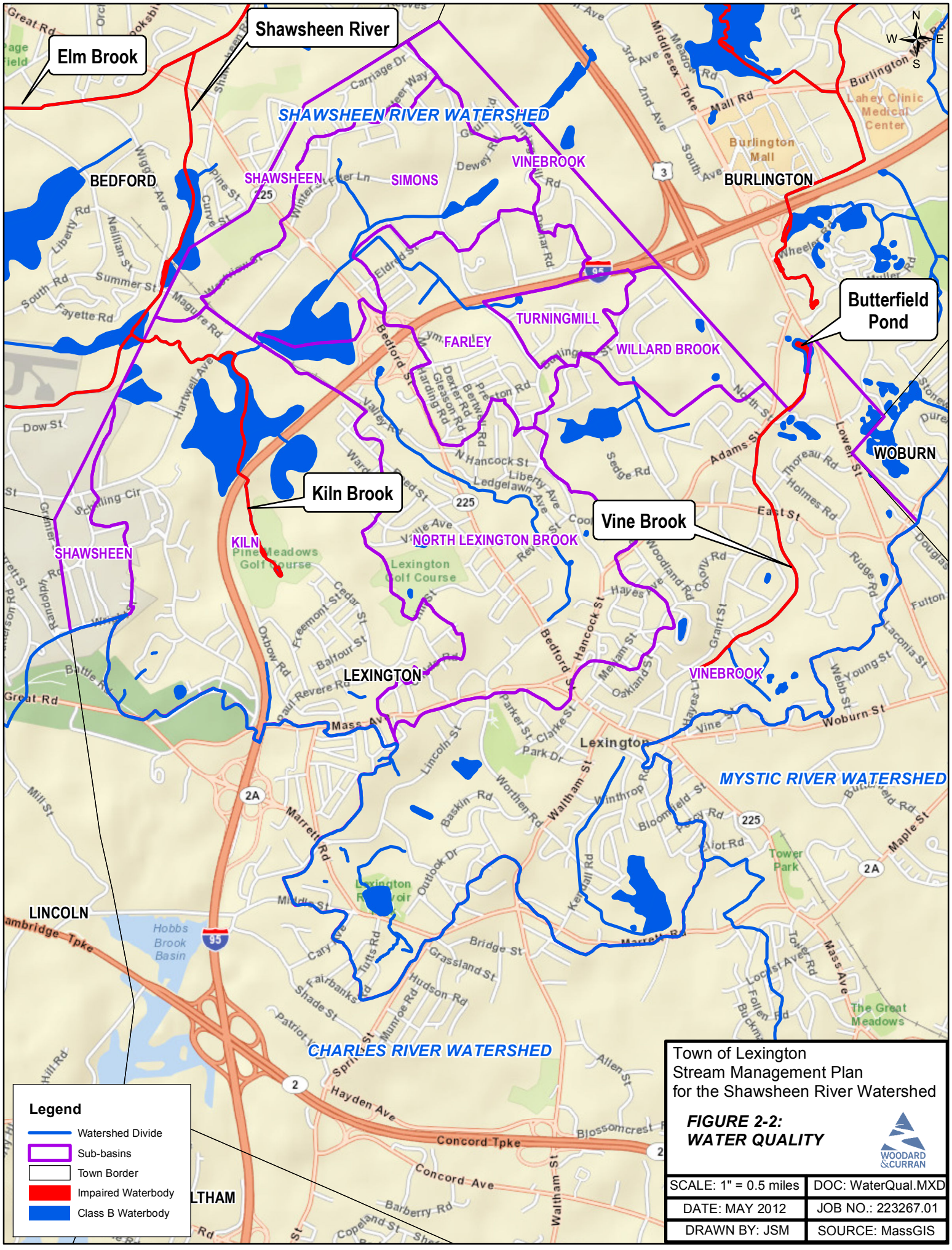


Town of Lexington
Stream Management Plan
for the Shawsheen River Watershed

FIGURE 2-1:
IMPERVIOUS COVER & LAND USE

WOODARD &CURRAN

SCALE: 1" = 3,500 feet	DOC: Figure2-1.MXD
DATE: JAN. 2012	JOB NO.: 223267.01
DRAWN BY: JSM	SOURCE: MassGIS


Elm Brook
Shawsheen River
SHAWSHEEN RIVER WATERSHED
BEDFORD
SHAWSHEEN
SIMONS
VINEBROOK
BURLINGTON
Burlington Mall
Lahey Clinic Medical Center
Butterfield Pond
TURNINGMILL
FARLEY
WILLARD BROOK
WOBURN
Kiln Brook
Vine Brook
KILN
NORTH LEXINGTON BROOK
Pine Meadows Golf Course
Lexington Golf Course
LEXINGTON
MYSTIC RIVER WATERSHED
Tower Park
LINCOLN
Hobbs Brook Basin
CHARLES RIVER WATERSHED
The Great Meadows
Legend
Watershed Divide
Sub-basins
Town Border
Impaired Waterbody
Class B Waterbody
Town of Lexington
Stream Management Plan
for the Shawsheen River Watershed
FIGURE 2-2:
WATER QUALITY
WOODARD &CURRAN
SCALE: 1" = 0.5 miles
DOC: WaterQual.MXD
DATE: MAY 2012
JOB NO.: 223267.01
DRAWN BY: JSM
SOURCE: MassGIS

2.2 STREAM SURVEY

As part of the stream assessment, Woodard & Curran and town staff performed a field inspection of the survey areas and culverts in the Shawsheen River watershed within Lexington, as identified on Figure 1-1. The survey included a physical inventory of stream corridor conditions, with a focus on identification of impediments to drainage, obvious flood plain constrictions, and intact riparian areas that can safely provide flood mitigation and ecological value. Stream survey activities and findings are further described in Section 3.

2.3 ROADWAY AND DRAINAGE SYSTEM OPERATION & MAINTENANCE

Proper operation and maintenance (O&M) of roadways and their drainage systems are critical to maintaining safe roads and effectively conveying stormwater. O&M practices also can impact water quality and quantity; as snow melts, road sand and salt, as well as litter and other pollutants, are transported directly via sheet flow or through the drainage system to waterbodies. Road salt and other pollutants can contaminate water supplies and at high levels are toxic to aquatic life. Sand can create sand bars or fill in wetlands and ponds, impacting aquatic life, causing flooding, and hindering use of these resources. However, frequent sweeping of impervious surfaces will remove particulate matter and associated contaminants from impervious surfaces before they can be mobilized by the next rain event. Routine catch basin cleaning helps maintain adequate catch basin sump storage, thereby allowing catch basins to efficiently capturing coarse sediments and debris. This section was developed as part of the Charles River Watershed Stream Management Plan, and has been updated accordingly.

Both the Town and MassDOT maintain drainage within Lexington. The Lexington Highway Division does not perform roadway and drainage system operation and maintenance on State roads. MassDOT, formerly MassHighway, performs maintenance on State Highways (Route 2, Route 128 and all entrance and exit ramps) and on the following roads in Lexington, as shown in Figure 2-3:

- Pleasant Street from #108 to #141;
- Concord Avenue at the entrance of Route 2;
- Waltham Street from #753 to #890;
- Hayden Avenue from #16 to Waltham Street;
- Hayden Avenue from #95 to Spring Street;
- Spring Street from #128 to the end of the overpass of Route 2;
- Summer Street from #6 to the Arlington town line;
- Lowell Street from intersection of Maple Street to #114;
- Bedford Street from Bike Path to the Bedford town line;
- Marrett Road; and
- Maple Street.

Woodard & Curran assessed the Town's and MassDOT's practices regarding:

1) sand/salt application;

2) snow removal and storage;

3) street sweeping; and

4) drainage system maintenance.

Practices related to these four types of maintenance activities were evaluated with respect to: requirements of the 2003 General Permit for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems (MS4s); the draft NPDES General Permit for Discharges from Small Municipal Separate Storm Sewer Systems (MS4) located in North Coastal Massachusetts; MassDEP's Snow Disposal Guidance (Guideline No. BRPG01-01); and MassDEP Policy #BWP-94-092: Reuse & Disposal of Street Sweepings.

2.3.1 Sand and Salt Application

The Lexington Highway Division applies de-icers to town roads using two methods: brine pre-treatment and standard rotating spreaders. In 2010-2011, the Town began using brine pre-treatment to reduce the amount of salt used. The Town also uses rotating spreaders on the back of trucks to apply a sand and salt (sodium chloride) mixture to the roads. Both the effectiveness of the brine and the sand-salt ratio are temperature and weather dependent. The Highway Division uses its best professional judgment for de-icing methods and application rates depending on conditions observed. The Town tracks the tons of salt by load and by storm, and calibrates as needed.

As needed, the Town also applies sand and salt to parking lots and dedicated roads on public properties, including schools, town administration buildings, libraries, police and fire stations, the visitor center, and water and sewer properties.

According to the *MassDOT Snow and Ice Control Generic Environmental Impact Report*, for most multi-lane roadways and secondary roads, the deicing applications consist of salt (straight sodium chloride) or pre-mix of sodium chloride and calcium chloride at a 4 to 1 ratio. The general practice consists of salt application at a rate of 240 lbs. per lane mile. MassDOT also uses liquid calcium chloride as either a pre-wetting agent or it is applied directly to the pavement. This direct pavement application of liquid calcium chloride can be performed both prior to the storm for anti-icing purposes or as a deicing method during the storm.

A mixture of sand and sodium chloride is sometimes used, particularly on roadway sections with steep grades, ramp sections and hazardous intersections. Very rarely is straight sand used because it has no effect on preventing ice bond formations and it has proven very costly to clean up and dispose of after the season, and it can accumulate within the roadway drainage system and be washed into receiving water bodies.

There are no designated "reduced salt" areas on town-maintained roads. Some portions of the state highways are designated and labeled as "reduced salt areas," as listed below and shown on Figure 2-3:

- Interchange at Route 2A, 1 mile westerly and 0.5 mile easterly;
- Interchange at Route 2, 1.8 miles westerly and 0.6 mile easterly; and
- Portion of 128 (I-95) from the Waltham town line to the interchange with Route 4 & 225.

MassDOT's standard practice in reduced salt areas is to maximize the use of pre-mix and liquid calcium chloride as alternative deicers, to reduce the quantity of granular sodium chloride. MassDOT closely

monitors reduced salt zones during storms to ensure the proper timing of salt applications and minimizes the potential for overuse of deicing chemicals. Using pre-mix, which is a 4 to 1 blend of sodium chloride and calcium chloride, results in a 20% reduction in sodium chloride content compared to pure (straight) sodium chloride. Pre-mix is also mixed with sand to counter the "greasy" film that can be left on the road surface caused by calcium chloride. Thus, actual deicing applications in reduced salt areas generally consist of a mixture of sand and Pre-mix at a 1:1 ratio and applied at a rate of 240 lbs. per lane mile. The Pre-mix/sand mixture results in a 60% reduction in the amount of sodium chloride applied in the reduced salt zone area compared to using straight sodium chloride.

All town salt storage is located at the Public Services Building on Bedford Street. All stockpiles are in the building. The loading area is sloped so runoff flows into the building. There is a small, uncovered container near the entrance to the Public Services Building for residents to take free buckets of sand in the winter. There are also two covered MassDOT facilities that store de-icing materials located in the Town of Lexington: one off Interstate 95 at Route 2A, and one off Route 2 near Watertown Street. These facilities allow for all salt loading operations to take place under cover to prevent spillage beyond the structure.

2.3.2 Snow Removal and Storage

The Lexington Highway Division plows streets and sidewalks throughout the winter season. Snow is piled on the sides of the roads. Occasionally, typically in late December or early January, it is necessary to remove snow in the downtown area. In these instances, snow is stored in an upland area on Westview Street, off Bedford Street, just beyond the Westview Cemetery (see Figure 2-3). This location is within the Shawsheen River watershed in Lexington.

2.3.3 Street Sweeping

The Highway Division sweeps all streets a minimum of twice each year using a Town-owned mechanical broom sweeper. Sweeping is conducted continuously from spring through the fall until all streets have been swept twice. Sidewalks in the downtown area are swept once every year. School parking lots and roads are swept twice per year, typically in the spring and in late summer prior to the start of the school year. Street sweepings are temporarily stored at a town facility off of Hartwell Avenue for dewatering, within the Shawsheen River watershed (see Figure 2-3).

Sweepings are stored at the Highway Facility and are transported to a regulated landfill facility for disposal. The Town conducts analytical testing on the stored material and tracks dry weight of the material as it goes off site. At this time, the Town does not record the amount of material removed by location.

Most state roads are swept annually during the spring or early summer. Other state roads are swept by MassDOT on an as-needed basis. Sweeping of state roads is also conducted in conjunction with a structural project or to address a drainage backup problem. MassDOT District 4 utilizes mechanic broom sweepers. District 4 does not store any street sweepings at any facilities in Lexington.

2.3.4 Drainage System Maintenance

The Town has contracted with a vendor for catch basin cleaning and only conducts limited catch basin cleaning in-house. The contractor cleans each catch basin throughout Town once per year with a clam shell truck. No information about the catch basins is collected by the vendor during cleaning. Material

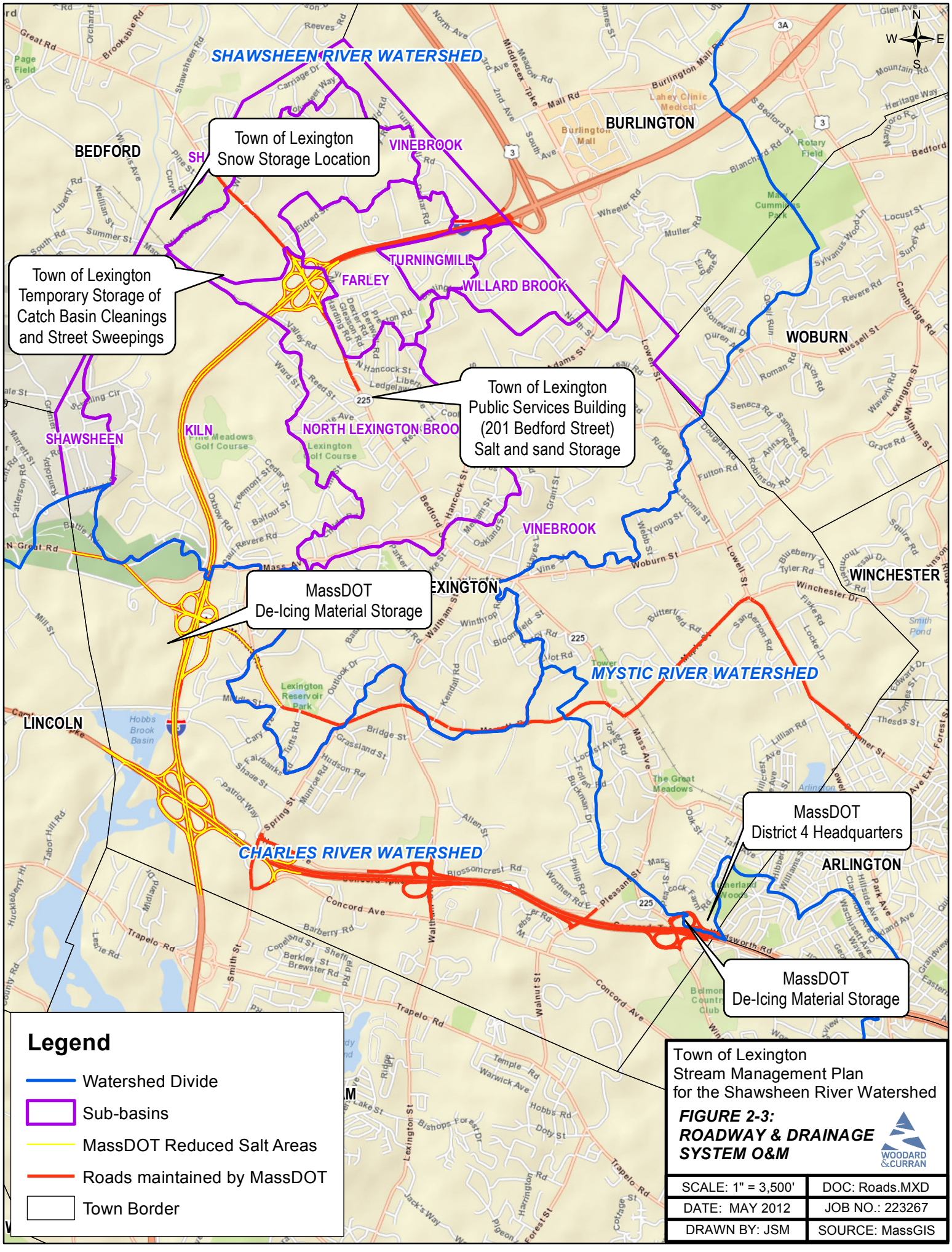
removed from catch basins is temporarily stored and dewatered at the same facility as the street sweepings, the Town facility off Hartwell Avenue, before being transported to a regulated landfill facility for disposal. There is no program currently in place to measure or record the quantities of street sweepings or catch basin debris generated each year.

The Town's drainage maintenance program is currently "reactive." In response to previous flooding or other issues, the Town cleans some catch basins more often than twice per year and clean drain lines in the system by jetting, as needed. The Town owns two vactor jet trucks for immediate response. The Town also has TV equipment to inspect the pipes, but camera work and sewer/drain line cleaning is typically completed by a local contractor. In addition, the Town has an annual contract for catch basin repairs.

Town personnel and volunteer Watershed Stewards maintain some of the Lexington streams, such as Vine Brook, by removing fallen trees, branches, and other material. Occasionally, Town staff from the Engineering Division will remove sediment from crossings. The Highway Division also contracts cleaning (i.e., Vine Brook).

MassDOT's drainage system maintenance program is also currently "reactive." MassDOT conducts catch basin cleaning and other drainage system work on an as-needed basis, typically in response to a problem or in conjunction with a structural project. MassDOT inspects most catch basins annually. MassDOT District 4 and its contractors utilize both clam shell and vactor trucks for catch basin cleaning. District 4 does not store any catch basin cleanings at any facilities in Lexington.

In addition, there are structural stormwater Best Management Practices (BMPs) within the I-95 northbound rest area that are monitored and maintained by McDonald's Corporation.


SHAWSHEEN RIVER WATERSHED
Town of Lexington
Snow Storage Location
Town of Lexington
Temporary Storage of
Catch Basin Cleanings
and Street Sweepings
Town of Lexington
Public Services Building
(201 Bedford Street)
Salt and sand Storage
MassDOT
De-Icing Material Storage
MYSTIC RIVER WATERSHED
CHARLES RIVER WATERSHED
MassDOT
District 4 Headquarters
MassDOT
De-Icing Material Storage
BEDFORD
BURLINGTON
WOBURN
WINCHESTER
ARLINGTON
LINCOLN
VINEBROOK
TURNINGMILL
FARLEY
WILLARD BROOK
KILN
SHAWSHEEN
NORTH LEXINGTON BROO
Legend
Watershed Divide
Sub-basins
MassDOT Reduced Salt Areas
Roads maintained by MassDOT
Town Border
Town of Lexington
Stream Management Plan
for the Shawsheen River Watershed
FIGURE 2-3:
ROADWAY & DRAINAGE
SYSTEM O&M
WOODARD &CURRAN
SCALE: 1" = 3,500'
DOC: Roads.MXD
DATE: MAY 2012
JOB NO.: 223267
DRAWN BY: JSM
SOURCE: MassGIS

3. STREAM SURVEY

This section summarizes stream survey actions and results. Photographs are included in Appendix A. The field assessment was conducted using digital forms. The database is included as Appendix B.

3.1 FIELD INVESTIGATION

Woodard & Curran and the Town conducted a physical inventory of Survey Areas and stream crossing infrastructure conditions, with a focus on identification of impediments to drainage, obvious flood plain constrictions, and intact riparian areas that can safely provide flood mitigation and ecological value. Specifically, the team conducted assessment of stream and floodplain morphology to document "natural" conditions that may influence flooding and conducted infrastructure assessment of streams to assess the impact of manmade structures on flooding and infrastructure condition.

At a meeting on June 16, 2011, Woodard & Curran and the Town identified known issues and finalized the stream survey areas. The survey protocol and database for the field collection developed in the Charles River watershed project were used for the Shawsheen River watershed. Table 3-1 summarizes the field collection items. The populated database is attached in Appendix B.

Table 3-1: Items Assessed in Field Investigation

Category Assessed	Items Assessed
Structures	• Structure Type • Material • Length • Condition • Inlet and Outlet Condition, Span, and Clearance
Crossings	• Pavement and Crossing condition • Length • Abutment Height, including wildlife barrier • Adjacent Pollution Sources • Erosion Concerns
Stream Reaches	• Channel Stability, Bed Material, Bank Materials • Adjacent Fill/Channelization • Bank and Channel Width and Depth • Bank Erosion Conditions • Streamside Vegetation • Invasive Species
Stormwater Outfalls	• Evidence of dry weather flow

Data were collected at 35 stream crossings located along the main channels of the seven named streams within the Shawsheen watershed in Lexington. The crossings were initially identified based on Town of Lexington's GIS layers. Certain crossings, or portions of crossings, along the main channels were not assessed due to access restrictions. Several crossings were assessed that were not identified on existing maps. Stream channels were assessed both above and below stream crossings and throughout Survey Areas. Certain stream segments were not accessible due to soft substrate (muck), poison ivy and/or

extensive vegetation. During the main stem stream inspections, any tributary identified as potentially adversely contributing to the main stem was noted.

Table 3-2 provides a summary of the survey activities, including dates of site visits, accomplishments and other comments.

Table 3-2: Stream Survey Activities

Date	Personnel	Location	Purpose and Comments
June 15, 2011	Zach Henderson (W&C) Paul Hogan (W&C) Bob Rafferty (W&C) Janet Moonan (W&C) John Livsey (Town) Michael Flamang (Town) Dave Pavlik (Town) Karen Mullins (Town) Emily Schadler (Town)	Samuel Hadley Public Services Building, Lexington, MA	Meeting to identify areas for survey, develop survey protocol, identify known issues and obtain information (access points, safety concerns, and conveyance needs).
August 4 through 5, 2011	Zach Henderson (W&C) Dave Pavlik (Town)	Vine Brook (Survey Areas A, C, and D), Kiln Brook (Survey Area J), North Lexington Brook (Survey Area I)	Assess stream channel, stream crossings and outfalls.
August 11, 2011	Zach Henderson (W&C) Bridget Mitchell (W&C) Dave Pavlik (Town)	Downtown (Survey Area B), Willard's Woods (Survey Area H), Culvert off Hartwell Avenue at Kiln Brook	Assess opportunities for BMP retrofits, Day lighting opportunities, and culvert replacement
August 12, 2011	Zach Henderson (W&C) Dave Pavlik (Town)	North Lexington Brook (Survey Area I), Willard's Woods (Survey Area H)	Assess stream channel, stream crossings and outfalls

Date	Personnel	Location	Purpose and Comments
September 14, 2011	John Livsey (Town) Mike Flamang (Town) Dave Pavlik (Town) Emily Schadler (Town) Bob Rafferty (W&C) Paul Hogan (W&C) Zach Henderson (W&C) Bridget Mitchell (W&C) Stew Kennedy (Steward) Carolyn Levi (Steward) Bob Hausslein (Steward)	Lexington Public Services Building	Present and discuss interim findings from the Stream Survey
November 3, 2011	Zach Henderson (W&C) Dave Pavlik (Town)	Visited 7 crossings in Simons, Farley, and Kiln Brook sub-basins	Assess stream crossings, collect data and photos
December 9, 2011	John Livsey (Town) Mark Valente (Town) Dave Pavlik (Town) Bob Rafferty (W&C) Janet Moonan (W&C)	Lexington Public Services Building	Discuss activities and operations that affect stormwater, drainage, and stream management, and discuss Town's priority of recommended projects.
December 16, 2011	Zach Henderson (W&C) Dave Pavlik (Town)	Vine Brook (Survey Area A and C), Parker Meadow Pond (Survey Area I)	Assessed bank failure, Pond operation, and South Vine Brook at Kendall Road stream cleaning needs
December 27, 2011	Zach Henderson (W&C) Dave Pavlik (Town)	Kiln Brook downstream of Survey Area J	Assessed stream channel, Pine Meadows, and I-95 Crossing
January 6, 2012	Janet Moonan (W&C) Bridget Mitchell (W&C)	Brent Road, Hathaway Road, (Survey Area G), Revere Street (Survey Area I)	Assess crossings and bank failure.
March 30, 2012	John Livsey (Town) Dave Pavlik (Town) Karen Mullins (Town) Emily Schadler (Town) Bob Rafferty (W&C) Janet Moonan (W&C) Bridget Mitchell (W&C)	Samuel Hadley Public Services Building, Lexington, MA	Reviewed recommendations from field work, prioritized projects and action items

3.2 OBSERVATIONS BY SUB-BASIN AND SURVEY AREA

As is the case in the Charles River watershed in Lexington, it is apparent that most of the streams in the study area have been historically straightened and/or dredged for drainage enhancement, flood management and to enhance developable areas in town. Despite being channelized these streams largely appear to be aggrading or are stable. Of the assessed reaches, 77% were aggrading or stable and only 23% were degrading. Segments of streams where aggradation dominates are predominately low or very low gradient reaches (e.g., the South Branch of Vine Brook drops 6' over 3300' for an average slope of less than 0.5%). Urban streams have multiple stream crossings, further reducing hydraulic capacity, and which create drainage issues and excessive accumulations of organic or sediment material. Stream reaches on the upper Kiln Brook above Wood Street, the upper North Lexington Brook above the Public Works facility, and the upper South Branch of Vine Brook are examples of stream segments subject to conveyance problems given natural topography and numerous stream crossings. In low-gradient reaches even minimal in-stream blockages can contribute to stagnant conditions and extensive organic material accumulation with likely impacts on hydraulic conveyance efficiency and stream water chemistry. Low-gradient stream reaches such as upper Vine Brook and upper North Lexington Brook are more likely to be impacted by even minor downstream flow constrictions (man-made or natural). Lower sections of Kiln Brook and Simons Brook appear to be very low gradient but limited development in portions of those sub-basins may limit the "impacts" of poor drainage. Conversely, portions of both North Lexington Brook and Kiln Brook do appear to have higher stream gradients, improving hydraulic efficiency but also making stream channels subject to degradation. Bank undercutting was more evident in these reaches. In all cases, stream reaches do not appear to have access to floodplains under typical annual bankfull events, which is common in unaltered stream environments. This lack of access to floodplains increases the likelihood of transport of organic debris through channels and into crossings and closed drainage systems increasing maintenance requirements. We found Kiln Brook generally had good water quality and provided habitat.

All "field inlet" types of culverts should be evaluated for trash rack and debris rack. The migration of woody debris into the crossings and closed drainage system is likely to be extensive in Lexington, particularly in the Vine Brook, and may be mitigated by improvements to inlets. See Figure 105, page 39 of Appendix A for example.

Several areas within existing public ownership (e.g., wetlands near Lincoln Park, Parker Meadow, and Bridge School) offer opportunities for engineered wetland enhancement and/or polluted stormwater runoff mitigation.

Field identifiers referenced in the following sections are included on the Recommended Plan figure and the Fact Sheets in Section 7.

3.2.1 Vine Brook

- Vine Brook is a large sub-basin with two primary tributaries. The North Branch which originates in the area around the Old Reservoir and the South Branch with originates in the extensive wetland areas near the Kendall Road and Grapevine Avenue intersection. Much of this stream is conveyed via underground drainage pipe network (e.g., closed drainage) and appears to be subject to significant developed area stormwater runoff. Despite likely increases in peak flows within this sub-basin due to development, the stream channel largely appears to be stable or aggrading.
- Survey Area C: The stream crossing at Kendall Road (CR1505) is almost completely buried at its outlet. The crossing alignment is problematic given stream flow directions from both east and

west and some channel realignment for western stream approach may be necessary to allow a new culvert drainage structure to function effectively. Enhancing stream channel drainage in this area and downstream to Worthen Road will be necessary as a part of improvement of the crossing structure and as long-term maintenance for effective drainage in this portion of sub-basin.

- Survey Area C: Two outfalls upstream of Kendall Road have sand deposition. One outfall discharges from drainage on Apollo Circle (OF15-15) and one discharges drainage from Malt Lane and Marrett Road (OF15-16). These outfalls need to be cleaned.
- Possible pipe constriction at Winthrop Road (CR1507) may contribute to poor drainage and accumulation of organic material upstream. CR1507 is a 48" pipe downstream of 68" pipe at Worthen Road. Also noted consistent flow in outfall under road crossing here. The consistent dry weather flow should warrant additional drainage area investigation. No obvious signs of illicit discharge (e.g., visual or olfactory), but flow appeared to be consistent at this location during time of survey and may be tributary to wetland system off of Shelburne Road. The drainage system map in this area is not fully connected.
- Survey Area E: The inlet to CR1501 has a fallen bar screen (Figure 2).
- Downstream of Survey Area E: CR1503 is the inlet to underground drainage that travels by Lincoln Park and Parker Field, discharging at CR1514. CR1503 has a bar rack (Figure 3) that could be replaced to improve reduction in clogging of the underground drainage system.
- There is an opportunity for wetland enhancement at the Bridge School, in the area above CR1503. This is a publicly owned parcel and adjacent to a school. An engineered wetland area may mitigate flooding, improve water quality, and reduce vegetation and organic debris migration into closed drainage portion of North Branch tributary which is just downstream. This is also an excellent educational opportunity. There is also the opportunity to provide treatment for runoff from the school.
- Survey Area D: Field inlets providing wetland area drainage into North Branch closed drainage system could be modified to enhance open water, wetland attributes, flood control or polluted stormwater runoff mitigation in both wetland areas north and south of Lincoln Park and at a minimum should be protected with trash rack and debris protection. A field evaluation of "daylighting" options identified within the Lincoln Park Master Plan (Sasaki, 2002) appeared to be viable based on field review. It is not clear that hydraulics as proposed in Master Plan have been evaluated. Any additional storage in these wetland areas would need to consider "upstream" stormwater outfalls and effective drainage off of Lincoln Street. Outfall OF15-36, just north of Lincoln Park parking area was assessed and is already entirely submerged. Any other "daylighting" of the North Branch closed drainage system would require extensive vegetation removal and/or change of existing use and is not advised as an option to enhance drainage or water quality. The closed drainage system in Survey Area D should be CCTV'd and the drainage system mapping in this area should be confirmed.
- Survey Area F: CR1514 is the 48" outlet of major closed drainage system on lower portion of North Branch of Vine Brook. There is extensive iron staining at this outlet compared to water color from South Branch of Vine Brook. The discharge from this outlet was also foamy at time of inspection. Groundwater seepage may contribute to this staining but could also indicate illicit discharge issues.
- Survey Area B: The Town clears woody debris from inlet at CR1508 constantly.

- Survey Area B: There are numerous opportunities in the downtown area for structural stormwater retrofits to manage volume of runoff and achieve water quality improvements.
- Survey Area A: Vine Brook downstream of CR1509 is generally quite constrained, and there are not a lot of places it would be wise to allow the brook to move laterally.
- Survey Area A: Extensive sand/sediment accumulation below CR1509 (outlet of closed drainage system at Hayes Lane) may be contributing to minor lateral stream migration and bank failure. This sedimentation was common in this portion of Vine Brook below Hayes Lane but not as visible downstream at Birchwood Road (CR1510). This is a likely location for sediment deposition in this reach given pipe conveyance and urbanization upstream of this outlet.
- There is sediment deposition upstream of CR1517, which is a bridge. The bridge itself has capacity, but a hydraulic evaluation of the area will confirm. There is also approximately 60 feet of bank failure, six feet wide and eight feet high (to water line) upstream. To properly repair this failure, it might require moving the bike path. Bank stabilization should be coupled with stream cleaning.
- CR1512 and CR1513 have minor wingwall failure at each location. Cobble and mortar wingwall detaching from lower portion of both structures. Failure at CR1512 is approximately 6' H x 4' W and may become a problem. Otherwise structures are in good condition.
- CR1519 is at the end of Hathaway Road. The stream mostly bypasses this culvert due to the natural wetland system. There were no structural or other issues observed at the time of the field visit.
- Survey Area G: CR1518 in Willard's Woods is used as public access to the woods. This culvert has erosion and safety concerns, bank undercutting upstream, and sediment buildup in the culvert and upstream.
- Survey Area G: CR1516 is a 24" RCP that then drains into extensive closed drainage system in Suzanne Road/Millbrook Road neighborhoods. No issues with structural configuration of inlet but extensive upstream woody debris likely to be migrating into storm drain system at this field inlet periodically compromising drainage in this area.

3.2.2 Kiln Brook

- CR1710 at Wood Street has slightly failing wingwall and skewed inlet to stream alignment. There is a fence in the brook upstream from this culvert that causes debris buildup. Both the culvert and the fence location should be monitored.
- Survey Area J: CR1711 is a closed drainage system under the Oxbow Road/Constitution Road neighborhood. Discharges from both I-95 and upstream of I-95 may contribute to hydraulic issues in this drainage system and is in need of further evaluation. Area of I-95 that discharges to this location is unknown. No major structural or sedimentation impacts noted at this inlet or outlet but downstream section of Kiln Brook (several hundred meters) exhibit signs of degradation/incision, bank undercutting, and sediment buildup most likely due to stormwater discharges despite extensive streamside vegetation in area above Pine Meadows Country Club. This portion of the brook is contributing to sediment building in the pond in Pine Meadows Country Club.

- Pine Meadows County Club has periodic flooding problems, as further described by Tutela's April 2008 Report on Stormwater and Drainage Improvements at the Pine Meadows Golf Club for the Town of Lexington, MA.
- The headwall of CR1712 at I-95 was submerged, and therefore the culvert was not accessible. The water backup did not appear to be due to sediment buildup, but instead is hydraulically dammed due to downstream wetlands area and low gradient.
- The inlet of CR1705 is almost entirely submerged, and the outlet is entirely submerged. Upstream of this outlet is wooded swamp, with lots of recently dead trees. Beavers and mallards are present in this area.
- CR1706 is a twin 48" culvert, with a flow alignment issue on the left bank. Culvert is generally in good shape.
- CR1708 has major structural issues and it is our understanding is slated for replacement.
- CR1709 is a twin 36" culvert. This culvert may be contributing to upstream flooding. It effectively creates about 17 acres of wetland upstream, as further described by Tutela's April 2008 Report on Stormwater and Drainage Improvements at the Pine Meadows Golf Club for the Town of Lexington, MA.

3.2.3 North Lexington Brook

Survey Area I:

- The headwaters of North Lexington Brook are fed by a major stormwater outfall (OF15-30). This 48" outfall appears to accommodate drainage from significant commercial/light industrial area, formerly including a gas station, and an extensive drainage network. Stream had a faint odor of petroleum both times it was visited. There was no visual presence of pollution. Extensive areas of sand from winter road maintenance appear to be flushed into headwaters of North Lexington Brook at this location. Because the outfall is partially submerged, conventional sampling cannot be conducted. An urban drainage assessment to identify opportunities for stormwater management and illicit discharge detection and elimination procedures should be conducted in this commercial/light industrial area.
- CR1801 crossing appears to be in satisfactory condition (minor inlet erosion occurring at wingwall due to discharge from 48" outfall). This location should be monitored for further inlet degradation.
- North Lexington Brook upstream of Parker Meadows is low gradient. The channel is aggrading and filling up with woody debris, which contributes to backwater conditions and may be influencing the 48" stormwater outfall. That being said, it may not be prudent to remove substantial material or woody debris as it may overwhelm Parker Pond and the downstream system.
- The section of stream channel through Parker Woods is natural. There may be an opportunity to manage peak flows and deposition of sediment and other pollutants by controlling the Parker Meadow Pond. The outlet is approximately 8 feet across and 12" at bankfull depth. The Town has previously adjusted the outlet of the pond, and the Stewards have removed debris from the outlet. This pond is a good place to store floodwaters.

- Just off Parker Meadow is Hancock Street. There are two outfalls that discharge drainage from Hancock Street to the meadow. There have been some drainage issues in the area off Hancock Street, next to the wetlands.
- CR1803, which is a 36" CMP located at Revere Street, had only 12" open area from crown to water elevation at the time of survey and was over 50% blocked with organic debris and sediment. This may create a hydraulic restriction for upstream reaches due to size and slope of pipe. It is recommended that this crossing be considered for full replacement. The Town's drainage improvement project for the Minuteman Bike Path does not address this crossing.
- Just downstream of the outlet of CR1803, on the southwest side of the stream bank, is a house that has a concrete path along the garage which is being undermined by stream. The instability of stream bank adjacent to this structure could be addressed as a part of a crossing structure reconstruction. The project could include armoring along streambed, or could include extending the culvert past the unstable bank.
- After the Revere Street culvert (CR1803), the stream changes and gets some gradient.
- CR1810 appears to have been recently reconstructed, but crown of pipe is relatively low compared to slope of stream upstream of crossing and may be likely to be overtopped again in future high flow events, particularly if woody debris contributes to blockages at this location. Trail surface elevation forces crown elevation and may not be possible for adjustment. Additionally, extensive ditch flow along rail trail appears to contribute to destabilization at this crossing. A project at CR1803 may consider addressing ditch flow in vicinity of CR1810 which appears to be sourced from Revere Street. Town is reconstructing this culvert as part of the Minuteman Bike Path project.
- Old granite block crossings on this section of North Lexington Brook appear to be in pretty good condition with the exception of minor block displacement at CR1802 and CR1805.
- Floodplain area around CR1805 may offer possibility for stream daylighting and natural stream channel design opportunity. The stream passes through CR1805 and a short section of open channel on Lexington Public Works property. Stream reconstruction on the north side of the rail would avoid the need for multiple crossings under the trail, move confined channel away from public works facility and provide a nice demonstration of natural stream restoration. Higher gradient stream reaches (1 to 2%) can be fairly successfully reconstructed which would be required here. Extensive fill removal and private property adjacency may limit this opportunity.
- As shown in the photo of the stream upstream of CR1805, there is a discharge of iron to the brook from the wetlands treatment system outlet at the Public Services Building. This should be part of a post-construction BMP inspection. The map of the drainage system should be improved in this area.
- CR1806 at Bedford Street is owned by MassDOT. At time of the Stream Survey, there were no problems with it. This culvert has had clogging in the past, which resulted in flooding. There is a potential for significant property damage if this culvert backs up. MassDOT is aware of this issue.
- Downstream of CR1806, there is stormwater runoff from a bus facility. The facility has a gravel lot used for parking busses and storing sand and debris in piles, and there is an outlet through the woods that discharges runoff from the parking area. A landowner complained about erosion and muddy water.

- Field Staff did not see any obvious bacteria issues – not a lot of wildlife and not a substantial amount of water.

3.2.4 Willard's Brook

Survey Area H:

- The outlet of Willard's Pond discharges into CR1601. This inlet appears to have been constructed as a part of outlet control for pond and it is assumed that the underground portion of this crossing is constructed of hand-laid granite (numerous sinkholes visible along drainage alignment) and extends from the pond approximately 280' to North Street where drainage enters a 30" RCP culvert under the roadway. The section of closed drainage upstream of North Street to the Pond looks to have very good viability for daylighting given public property, probable daylighted stream slope (approximately 2%) and partially open old-field area above closed drainage with minimal large trees.

3.2.5 Simons Brook

- Generally, the upper portion of Simons Brook is actively degrading, and downcutting the banks of the brook. Once the brook hits the wetland area downstream of CR1901 at Bedford Street, the brook aggrades.
- CR1903 is located on Grove Street, just below Turning Mill Conservation Area. The inlet pipe has minor breakage. Runoff from Grove Street scours around the culvert pipe crown and may become a problem. There is presence of small woody debris in inlet. Inlet armoring may be necessary here. In the immediate upstream reaches, there is a pond impoundment. Installation of new or additional drainage on Grove Street may address this issue.
- CR1904 is located at the end of Hadley Road. A 36" culvert is in adequate condition. The culvert appears to be bypassed by stream through adjacent wetlands area. Downstream of this culvert is a large wooded wetland, which had major accumulation of woody debris. This area could provide an opportunity for a wetlands restoration project. The woody debris should be removed in a manner that balances preserving habitat with the removal. Also just downstream of the culvert, there is a large tree protecting a portion of the bank, which may become an issue. The lawn is mowed right to the edge of the stream bank. It might make sense to armor the edge of the outlet and remove the tree. At this point, the brook has high velocity and high gradient. There is also poor stream alignment in this area. The stream bypasses the culvert via a wetlands sort of area. Upstream of the culvert is an impoundment that causes poor flow into the inlet.
- CR1901 at Bedford Street is structurally sound, and capacity did not appear to be a concern. Following the outlet of this culvert, the stream enters a large wetland area.

3.2.6 Turning Mill and Farley Brooks

- CR2101 at Grove Street had minor sediment accumulation in the inlet. Flow in the stream is skewed due to the sediment buildup. The outlet is halfway submerged. Downstream of the culvert, the stream enters a wetland and is low gradient. Because there is a 35 foot abutment, this culvert would require a major effort to access and therefore no work is recommended at this time.
- Upstream of CR2101 is a trail crossing. Overtopping was evident, and the inlet was clogged. This crossing needs to be evaluated for removal or improvement.

- CR2102 at Eldred Street is a 60" RCP culvert. There was minor scour around the inlet, no headwall. Just upstream of the culvert, there was woody debris accumulation and newly downed trees. There is minor scour on the left bank. The inlet should be armored, and the debris and invasive shrubs should be removed. No problems with the outlet. Also, dry weather flow from the outfall in the culvert was observed.

4. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the findings from the stream assessment and stream survey efforts described in Sections 2 and 3, and presents recommendations to address these findings. Recommendations consist of projects, action items, and maintenance procedures. Fact Sheets included in Section 7 further detail the recommendations.

There are six categories of recommendations:

- in-stream (infrastructure restoration, drainage restoration, and wetlands protection);
- drainage investigation;
- stormwater retrofit;
- roadway and drainage system operation and maintenance;
- drainage maintenance procedures and restoration practices; and
- coordination with EPA's Phase II Small MS4 General Permit.

Section 5 summarizes the permits required for these recommendations, as well as the proposed permitting process. Potential funding opportunities for projects, action items, and maintenance procedures are identified in Section 6.

4.1 GENERAL FINDINGS AND CONCLUSIONS

Based upon the results of the Stream Assessment and Survey conducted by Woodard & Curran and the Town of Lexington, we conclude that:

1. Streams in the majority of the study area have been historically straightened and/or dredged. Without regular maintenance these streams will continue to fill in with sediment which will likely compromise urban drainage.
2. The highly developed nature of the Town's watersheds within the Shawsheen River basin (all subwatersheds greater than 10% impervious cover) make management of stormwater and conveyance critical.
3. Culverts under roadways are often compromised by debris and other inorganic sedimentation if they are not on the higher gradient sections of stream or are not bridge structures.
4. Sediment at culverts appears to be predominately from settlement of organic and inorganic material caused by downstream obstructions and low gradient stream flow.
5. Urban runoff (and specifically winter maintenance activities) from roads and other impervious surfaces have likely contributed to clogged culverts and outfalls.
6. Drainage outfalls were generally clear of obstructions, but stormwater discharges could be hydraulically restricted due to higher water tables caused by the lack of sediment and organic debris removal over time.
7. For conveyance improvements, the Town should prioritize projects that clear stream obstructions and sediment in culverts and stream channels, as opposed to upstream drainage infrastructure (pipe and catch basin) cleaning. However, any removal of stream obstructions and sediment should be carefully balanced with preservation of natural habitat.

8. Infrastructure structural conditions varied considerably, but are largely in fair to good shape. However, the culvert off Hartwell Avenue at Kiln Brook, at Revere Street and North Lexington Brook, Willard's Woods and Vine Brook, and Kendall Road and Vine Brook, should be considered for hydraulic improvements and/or replacement.
9. Extensive bank failure on Lower Vine Brook in vicinity of Saddle Club Road should be addressed. This may be accomplished by either stabilizing the bank or moving the bike trail.
10. To achieve a routine maintenance program for the drain outfalls and stream system, the Town must first undertake projects requiring capital funding and comprehensive permitting.
11. A routine low impact maintenance program should be instituted for several stream segments of low gradient.
12. Several opportunities exist for stream and wetlands protection and restoration.
13. Several areas in downtown Lexington appear to have very good opportunity for stormwater quality retrofitting in conjunction with village master plan implementation.
14. Several areas of concentrated urban development should be evaluated for structural management in order to reduce migration of sediments into streams and to reduce polluted stormwater runoff.
15. Stream daylighting demonstration project should be considered for Willard's Woods downstream of Willard's Pond.
16. Specific findings are discussed for each priority project/program in the Fact Sheets in Section 7.

4.2 PRIORITIZED LIST OF PROJECTS

Based upon the results of the field work conducted by Woodard & Curran and the Town of Lexington and from the group discussion held on March 30, 2012, priorities were identified to address infrastructure in need of substantial structural repair, address localized flooding, and improve public safety. Fact Sheet 2 in Section 7 lists the prioritization of the projects. The associated figure shows the location and priority of the projects, action items, and areas for ongoing maintenance. Projects are color-coded based on priority (red is high priority, orange is medium priority, and yellow is low priority).

4.3 IN-STREAM RECOMMENDATIONS

The areas that need infrastructure repairs, drainage restoration or wetlands protection are listed below.

Infrastructure Restoration	Drainage Restoration	Wetlands Protection
• Recycle Drive Crossing off Hartwell Avenue (Fact Sheet 3) • Revere Street Crossing at North Lexington Brook (Fact Sheet 4) • Willard's Woods Crossing at tributary to Vine Brook (Fact Sheet 9) • Daylight Willard's Brook at Willard's Woods (Fact Sheet 10)	• Revere Street Crossing at North Lexington Brook (Fact Sheet 4) • South Branch Vine Brook at Kendall Road (Fact Sheet 5) • Vine Brook Along Saddle Club Road (Fact Sheet 11) • Sherburne Road Area in South Branch Vine Brook (Fact Sheet 6)	• Bridge Elementary School at North Branch Vine Brook (Fact Sheet 13)

4.4 DRAINAGE INVESTIGATION RECOMMENDATIONS

Four areas have been identified where Woodard & Curran recommends additional investigation of the drainage infrastructure. Each of the following areas and proposed investigation items are further discussed in Section 7.

- Sherburne Road Area in South Branch Vine Brook (Fact Sheet 6);
- Oxbow Road Area adjacent to I-95 in Kiln Brook (Fact Sheet 7);
- Worthen Road at Headwaters of North Lexington Brook (Fact Sheet 8); and
- Winthrop Road Crossing at South Branch Vine Brook (Fact Sheet 12).

4.5 STORMWATER RETROFITS

There are opportunities to install structural stormwater retrofits such as rain gardens, box filter units, or depressed landscape areas/soil restoration projects in the Downtown area of Lexington (Fact Sheet 15). These retrofits could provide water quality benefits and reduction of volume runoff. Recommendations for retrofits are further detailed in Section 7.

4.6 ROADWAY AND DRAINAGE SYSTEM OPERATION & MAINTENANCE RECOMMENDATIONS

Recommendations related to snow removal, winter sanding and salting, street sweeping, and drainage system maintenance (such as catch basin and outfall cleaning) are described on the Fact Sheet 16 titled "Roadway and Drainage System Operation and Maintenance" in Section 7.

4.7 RECOMMENDATIONS FOR DRAINAGE RESTORATION

As part of the Charles River Watershed project, Woodard & Curran developed specifications for methods of stream cleaning with respect to the following regulatory performance standards and guidelines:

- Army Corps of Engineers Programmatic General Permit;

- Massachusetts Best Management Practices and Guidance for Freshwater Mosquito Control;
- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas;
- U.S. Department of Transportation Stream Stability at Highway Structures;
- Army Corps of Engineers Channel Rehabilitation: Processes, Design, and Implementation;
- Massachusetts Stream Crossing Handbook; and
- Massachusetts River and Stream Crossing Standards.

Fact Sheet 18 in Section 7 provides a brief overview of stream cleaning and maintenance activities, based on these standards and guidelines. These methods continue to be applicable to recommendations for drainage restoration for the Shawsheen River Watershed. The permit path associated with stream cleaning is further described in Section 5.

4.8 COORDINATION WITH EPA'S PHASE II SMALL GENERAL PERMIT REQUIREMENTS

As described in Section 1,1, EPA regulates the discharge of pollutants from Small Municipal Separate Storm Sewer Systems (MS4s) through their Stormwater Program and General Permits. Lexington is covered by the 2003 *General Permit for Storm Water Discharges from Small MS4s*. This permit expired on May 1, 2008, but has been administratively continued until the next general permit is in effect.

In 2010, EPA released a draft NPDES General Permit for Discharges from Small MS4 located in north coastal Massachusetts ("2010 Draft General Permit"). This draft General Permit includes new and increased stormwater management requirements. Among other requirements, the Town must address the Final Bacteria Total Maximum Daily Load for the Shawsheen River Basin by implementing measures to control the pollutants identified in the TMDL (fecal coliform bacteria) and documenting that these BMPs are adequate to meet the waste load allocations and load allocations in the TMDL.

Woodard & Curran reviewed both the 2003 and 2010 MS4 General Permits and identified opportunities to merge and coordinate recommendations from this report with requirements of the existing and pending MS4 General Permits, and also looked for opportunities to coordinate MS4 compliance activities with bordering communities. Fact Sheet 20 titled "TMDL and MS4 Permit Compliance" in Section 7 summarizes these findings.

5. PERMITTING REQUIREMENTS AND RECOMMENDATIONS

The prioritized projects and the long-term drainage restoration work require numerous local, state, and federal permits. Woodard & Curran assessed the following permits to determine for the applicability to the recommended work summarized in Section 4 and further detailed on Fact Sheets in Section 7:

- Local Conservation Commission Wetlands Order of Conditions;
- Certificate of the Secretary of Energy and Environmental Affairs on the Environmental Notification Form under Massachusetts Environmental Policy Act (MEPA);
- EPA Construction General Permit;
- EPA Dewatering General Permit;
- MassDOT Highway Access Permit;
- MassDEP 401 water quality certification;
- U.S. Army Corps of Engineers Department of the Army General Permit Commonwealth of Massachusetts;
- Massachusetts Historical Commission Project Notification Form (PNF);
- Massachusetts Endangered Species Act (MESA) Project Review;
- Chapter 91 waterways license; and
- Local permits (Permit to Open or Occupy Street/Sidewalk, Trench Permit, Tree Removal Permit, etc.).

Fact Sheets in Section 7 lists these permits, the required forms, permit agency, trigger, projects requiring the permit, permit timelines, application fees, reference information, and assumptions. Permits associated with each project, as well as permits potentially triggered by drainage restoration work, are specified on the each Fact Sheet in Section 7. In addition, the recommended permitting approach is presented in Section 7.

6. POTENTIAL FUNDING OPPORTUNITIES

This section presents a prioritized summary of grant and loan opportunities, including non-traditional grant sources, based on specific projects, funding program requirements, funding range, schedule for applications, estimate of application effort, targeted recipients, and other relevant information. Engineer's opinion of probable budgetary costs are included on the Fact Sheets in Section 7, and further cost information for structural projects is included in Appendix C. Additional information on funding opportunities for projects is included on the Fact Sheets in Section 7.

6.1 PRIORITIZED FUNDING OPPORTUNITIES

Woodard & Curran assessed over 50 federal and state grant and loan opportunities to identify potential funding for the recommended work summarized in Section 4 and further detailed in Section 7. Based on this assessment, Woodard & Curran identified the following environmentally-focused funding and service opportunities, which are applicable to one or more projects:

- Coordination with the East Middlesex Mosquito Control Project;
- Massachusetts Natural Resources Conservation Service (NRCS) Watershed Protection and Flood Prevention Program Grant;
- MA NRCS Wetlands Reserve Program Grant;
- EPA Wetlands Program Development Grant;
- EPA/U.S. Fish and Wildlife Association Five- Star Restoration Program Grant;
- MassDEP Clean Water State Revolving Fund Loan;
- Massachusetts Department of Conservation and Recreation Rivers and Harbors Grant;
- Massachusetts Division of Ecological Restoration River Restoration and Revitalization Priority Project Grant;
- Executive Office of Energy and Environmental Affairs Office of Coastal Zone Management Wetland Restoration Grants for Priority Projects;
- Massachusetts Division of Fish and Game Riverway's Stream Team Implementation Awards Grant; and
- Massachusetts Department of Conservation and Recreation (DCR) Recreational Trails Program.

Section 7 presents further detail on these grants and loans, contracting entity, eligible applicants, eligible projects, due date, links, and project for potential funding match. Additionally, traditional municipal programs could provide funds for specific projects that address other important municipal priorities. These include:

- Chapter 90 local transportation aid funding for road and drainage projects.
- Community Preservation Act (CPA) funds for open space (Willard's Woods).

Potential funding opportunities associated with each project are specified on each Fact Sheet in Section 7. A recommended funding approach is also discussed in Section 7.

6.2 ADDITIONAL FUNDING PROGRAMS

Other funding programs are available that can supplement the conventional programs described above; however, these programs have drawbacks that make them less attractive. Drawbacks may include the cost and effort to complete the application process, intense competition, agency's geographic preferences, low award value, burdensome reporting requirements, and restrictive project focus. However, some municipalities have had success by directly soliciting from the funding agencies and combining funds into a more comprehensive and cohesive funding program.

- NOAA Restoration Center;
- Gulf of Maine Council (in conjunction with NOAA Habitat Restoration Grants Program);
- American Rivers;
- EPA Targeted Watershed Grants;
- Section 319 Nonpoint Source Pollution Competitive Grants Program; and
- Section 604b Grant Program – Water Quality Management Planning.

7. FACT SHEETS

The Fact Sheets listed in Table 7-1 present the stream management plan for the Shawsheen River watershed within the Town of Lexington.

Table 7-1: Fact Sheets

Fact Sheet Number	Fact Sheet Title
1	Stream Management Plan for the Shawsheen River Watershed – Executive Summary
2	Projects – Summary and Prioritization
3	Project #1 – Infrastructure Restoration, Recycle Drive crossing off Hartwell Avenue
4	Project #2 – Infrastructure/ Drainage Restoration, Revere Street Crossing at North Lexington Brook
5	Project #3 – Drainage Restoration, South Branch Vine Brook at Kendall Road
6	Project #4 – Drainage Investigation / Restoration, Sherburne Road Area
7	Project #5 – Drainage Investigation, Oxbow Road Area
8	Project #6 – Drainage Investigation, Worthen Road at Headwaters of North Lexington Brook
9	Project #7 – Infrastructure Restoration, Willard's Woods Crossing at Vine Brook Tributary
10	Project #8 – Infrastructure Restoration, Daylight Willard's Brook at Willard's Woods
11	Project #9 – Drainage Restoration, Vine Brook along Saddle Club Road
12	Project #10 – Drainage Investigation, Winthrop Road Crossing at South Branch Vine Brook
13	Project #11 – Wetlands Protection, Bridge Elementary School at North Branch Vine Brook
14	Action Items
15	Downtown Stormwater Retrofits
16	Roadway and Drainage System Operation and Maintenance
17	Maintenance

Fact Sheet Number	Fact Sheet Title
18	Drainage Restoration Procedures
19	TMDL and MS4 General Permit Coordination of Activities
20	Permits – Potential Permits and Permitting Strategy
21	Permits – Summary and Projects Requiring Permits
22	Potential Funding Opportunities and Funding Approach
23	Potential Funding Opportunities – Summary and Projects for Funding

APPENDIX A: STREAM SURVEY PHOTOGRAPHS

APPENDIX B: PHOTOGRAPHS, STREAM SURVEY FIELD ASSESSMENT SHEETS, AND STREAM MANAGEMENT PLAN GEODATABASE

APPENDIX C: ENGINEERS OPINION OF PROBABLE COST FOR PROJECTS